

Sapling and herbaceous plant progression in the bottomland hardwood forest at the Olentangy River Wetland Research Park

Una Ilich

*College of Biological Sciences
The Ohio State University*

Introduction

Bottomland hardwood forests are typically high productivity systems, with certain general characteristics that include a high water table, soil saturation, and periodic flooding that typically follows an annual regime (Dudek et al., 1996; Harvan, 1998). In order to survive the inundated periods, the roots of the more flood tolerant woody plants have developed morphological or physiological adaptations that enable them to survive in soils that may be anaerobic during the growing season (Harvan, 1998). Tree species in the bottomland forest area range in their level of flood tolerance: the most tolerant are eastern cottonwood (*Populus deltoides*) and green ash (*Fraxinus pennsylvanica*); those of intermediate tolerance are box elder (*Acer negundo*) and red mulberry (*Morus rubra*); intolerant species include black walnut (*Juglans nigra*). Flood tolerance is determined by how long a tree can withstand inundation as well as how well it responds to high water levels (Loucks, 1987).

Periodically flooded systems tend to be more productive than those with extended periods of standing water, although this is not always the case (Brown and Peterson, 1983). This may be due to the facts that tree mortality is not significantly increased in areas that are only temporarily water-logged, that the flowing water washes in nutrients that aid tree growth, and that potentially non-native seeds that may be well suited to that type of ecosystem may also be washed in (Malecki et al., 1983; Knorr, 1998; Harter and Mitsch, 1997). In addition to these apparent effects, there are other advantages to temporary and short-lived flooding, including the potential for the chemical change of the soil into something more suited to the trees present, and the exclusion of competing vegetation's roots that the anaerobic soils ensure (Mitsch and Rust, 1984).

The season in which the flooding occurs also affects the growth and productivity of the vegetation (King and Grant, 1996). If the bottomland is flooded during the dormant season (winter), tree growth will not be affected, whereas if the flood occurs during the growing season (spring and summer), growth will most likely be deleteriously affected (Jones et al., 1989).

According to Acton et al. (1998) and Schamp and Mitsch (1997), the groundwater level in the Olentangy River Wetland Research Park (ORWRP) area has gone up with the construction of the experimental recharge wetland. Present water levels in the wells are not as uniform as they were in 1992 (Mitsch and Wu 1993), and this is due to flood

water from the Olentangy River as well as to the artificially increased water table from the construction of the experimental wetlands (Schamp and Mitsch, 1997). A higher water table coupled with periodic flooding may lead to a shift in species diversity and abundance in the bottomland hardwood area. A new hydrology and increased hydrochory would be some of the factors leading to an alteration in the vegetation of the bottomland.

The objective of the research is to investigate whether there had been any change in the bottomland sapling and herbaceous vegetation in terms of diversity and density since the establishment of the experimental wetlands. For that purpose, I conducted a plant survey of the bottomland forest at the ORW during the fall of 1998 and compared these result with those found in 1992, before construction of the experimental basins (Mitsch and Wu, 1993).

Methods

The ORWRP is located north of Dodridge Street in Columbus, Ohio, USA. The Park is bounded on the north and east by the bottomland hardwood forest, which in turn is bounded by the Olentangy River. The bottomland forest area ranges from 18 m to 60 m in width and is 700 m long (Dudek et al., 1996). It is separated from the river by a levee that was built about 100 years ago, but has several breaks in it that allow water to percolate into the bottomland area (Acton et al., 1997).

A lengthwise transect was established through the bottomland during the fall 1998. Figure 1 illustrates the study site and the approximate location of the 24 plots. Saplings and herbaceous vegetation were surveyed approximately every 60 m along theis transect, in 4 x 4 m and 1 x 1 m quadrats, respectively. The quadrats were located by choosing a random number between 0° and 360°, with 0° corresponding to due north. Depending on the number, I would orient myself in the given direction with the aid of a compass. I then randomly chose a number between one and 30; this marked the number of paces we would take from the transect in the direction already specified. The point that we reached marked the southeast corner of the study plot. A total of 12 quadrats were established for each sapling and herbaceous vegetation survey. Each species of sapling present in the plot was identified and counted to estimate the density in #/m². The same procedure was repeated for the herbaceous vegetation survey, but the density was not determined.

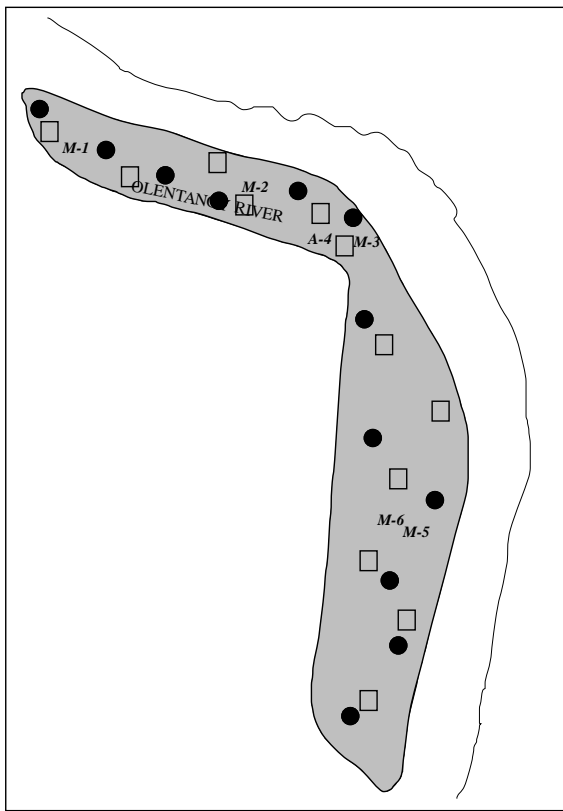


Figure 1. The Olentangy River Wetland Research Park study site, with approximate locations of wells (lettered and numbered), herbaceous vegetation plots (circles), and sapling plots (squares).

Results

Tables 1 and 2 list different species of sapling and herbaceous vegetation, with indication of individual number measured per quadrat. For comparison, our sapling density findings are listed along with those found by Mitsch and Wu (1992). The herbaceous vegetation data is presented as species and total number.

Discussion

Although I did not collect a large enough amount of data to make any strong conjectures, there do exist trends throughout that are suggestive of certain patterns and changes.

Saplings

There appears to have been a shift in the species and density of saplings present in the bottomland area, although a direct comparison is not possible because we did not sample the same plots as the 1992 study. It nevertheless appears that all sapling species have increased in density since 1992, regardless of their indicator status (Table 1). The fact that *Asimina triloba* and *Aesculus glabra* (Ohio

Table 1. List of total sapling species found in all twelve plots, as well as their total number, density (#/m²) in the present study and 1992, and indicator status (IS).

Species	#/plot	#/m ²		IS
		1998	1992	
<i>Acer negundo</i>	16	1.00	0.063	FAC+
<i>Aesculus glabra</i>	8	0.50	0.031	FACU+
<i>Asimina triloba</i>	17	1.06	0.69	FACU+
<i>Cornus florida</i>	11	0.69		FACU-
<i>Fraxinus pennsylvanica</i>	5	0.31		FACW
<i>Lonicera maackii</i>	109	6.81	0.25	NL
<i>Morus rubra</i>	9	0.56		FACU

FACW=facultative wetland species

FAC+=facultative species, tending toward upland

FACU=facultative upland species

FACU+=facultative upland species tending even more toward upland

Table 2. Herbaceous species found in the twelve plots.

Species	Common Name	#
<i>Alliaria petiolata</i>	Garlic Mustard	46
<i>Asarum canadense</i>	Wild Ginger	53
<i>Aster vimineus</i>	Small White Aster	6
<i>Daucus carota</i>	Queen Anne's Lace	1
<i>Geum canadense</i>	White Avens	3
<i>Polygonum hydropiper</i>	Smartweed	5
<i>Polygonum pennsylvanicum</i>	Pink Knotweed	28
<i>Rhus radicans</i>	Poison Ivy	8
<i>Sanicula gregaria</i>	Clustered Snakeroot	12
<i>Sanicula trifoliata</i>	Snakeroot	55
<i>Smilax rotundifolia</i>	Greenbriar	4
<i>Solidago bicolor</i>	Silver Rod	5
<i>Solidago canadensis</i>	Canada Goldenrod	15

buckeye) did not increase in magnitude nearly as much as *Acer negundo* (box elder) suggests that the two FACU+ species are slowly being replaced by more flood-tolerant species such as *A. negundo*. However, there are data for only three species to back up this conjecture, so no conclusions can be made for certain until a more extensive species survey is completed.

We did find that three species not present in 1992 had relatively high densities of saplings, including the flood-tolerant *Fraxinus pennsylvanica* (green ash). According to Mitsch and Wu (1992), *F. pennsylvanica* saplings were not present in the bottomland. Knorr (1998) conducted a study on the canopy structure (i.e., mature trees) of the bottomland and found that *F. pennsylvanica* did not contribute to the canopy in the bottomland hardwood forest. If hydrological changes occurred in the bottomland since the construction of the experimental wetlands in 1994, the flora which would be affected by these changes would be the saplings and the short-lived herbaceous species.

Herbaceous Vegetation

No comparisons can be made with our herbaceous

vegetation values and those from 1992 because I counted only total numbers and did not determine canopy cover of the vegetation as the previous study did (Mitsch and Wu, 1993). However, the data show that there is essentially no overlap between the species found in 1998 and those identified by Davidson in 1992 (*Rhus radicans*, a.k.a. poison ivy, was the only plant that was present in both studies). Even if a direct comparison is impossible since we did not survey the same plots, both methods did employ random sampling techniques. Therefore, the data gathered from both surveys (Mitsch and Wu, 1993; this study) should be somewhat telling of what is actually present in the bottomland hardwood forest.

Mitsch and Wu (1993) found only five species of herbaceous plants in their survey of the bottomland, those being *Urtica dioica* (stinging nettle), *R. radicans*, *Lactuca floridana* (Florida blue lettuce), *Osmorhiza claytoni* (hairy sweet cicely), and *Ranunculus* sp. (crowfoot), none of which I came across (aside from the exception noted above). In the 1998 survey, I found a total of thirteen different species; this count does not include three species of grasses that I was unable to identify. Several of the species that I found have indicator status that suggest that the hydrology is slowly shifting to wetter conditions. For example, *Polygonum hydropiper* (smartweed) is an obligate species and *Polygonum pennsylvanicum* is a facultative tending toward wetland species. *Polygonum pennsylvanicum* was the fourth most abundant species in total number, and it made up 11.6% of the total number of plants. This appears to be quite significant since this species was not even reported to be present in the bottomland in 1992.

The abundance of new herbaceous species in the bottomland may be a direct result of seed introduction through hydrochory; the flooding of the bottomland introduced these seeds into the system and the raised groundwater levels may have allowed them to germinate and propagate successfully. This, along with the presence of OBL and FACW species in the bottomland, suggests that the hydrology of the bottomland has undergone changes that are allowing new species to establish themselves, species which, under ideal conditions, live in soils that are saturated for parts of the year.

Acknowledgments

Thanks goes out to my research partners, Heidi Hopkins, Jeremy Applegate, and Ellen Kock. Their backgrounds and combined knowledge helped this study tremendously. I would also like to extend great appreciation to Dr. John Furlow at the OSU herbarium for his invaluable help with plant identification. Thanks to the bottomland hydrology team for providing us with their data, and to Changwoo Ahn for all his help. Finally, I would like to thank Dr. W. Mitsch for making this study possible.

References

- Acton, W.T., Mitsch, W.J., Wang, N., Bouchard, V., 1998. Flooding frequency and groundwater gradient of a riparian hardwood forest. In: W.J. Mitsch and V. Bouchard (eds.), *The Olentangy River Wetland Research Park at The Ohio State University, Annual Report 1997*. School of Natural Resources, The Ohio State University, Columbus, OH, pp. 225-234.
- Brown, S., and D.L. Peterson. 1983. Structural characteristics and biomass production of two Illinois bottomland forests. *American Midland Naturalist* 110:107-117.
- Dudek, D.M., J.R. McClenahan, and W.J. Mitsch. 1995. Dendrochronology studies at the Olentangy River wetland bottomland hardwood forest. In: W.J. Mitsch (ed.), *The Olentangy River Wetland Research Park at The Ohio State University, Annual Report 1994*, The Ohio State University, Columbus, OH, pp. 41-42.
- Dudek, D.M., J.R. McClenahan, and W.J. Mitsch. 1996. Tree growth responses to streamflow in a bottomland forest in central Ohio. In: W.J. Mitsch (ed.), *The Olentangy River Wetland Research Park at The Ohio State University, Annual Report 1995*, The Ohio State University, Columbus, OH, pp. 199-210.
- Harter, S.K. and W.J. Mitsch. 1997. Effects of hydrochory as a seed dispersal mechanism. In: W.J. Mitsch (ed.), *The Olentangy River Wetland Research Park at The Ohio State University, Annual Report 1996*, The Ohio State University, Columbus, OH, pp. 177-178.
- Harvan, M.J., 1998. Primary productivity of a bottomland hardwood forest at the Olentangy Wetland Research Park. In: W.J. Mitsch and V. Bouchard (eds.), *The Olentangy River Wetland Research Park at The Ohio State University, Annual Report 1997*, The Ohio State University, Columbus, OH, pp. 239-242.
- Jones, R.H., R.R. Sharitz, and K.W. McLeod. 1989. Effects of flooding and root competition on growth of shaded bottomland hardwood seedlings. *American Midland Naturalist* 121:165-175.
- King, S.L. and W.E. Grant. 1996. A simulation model of the impacts of green-tree reservoir management on bottomland hardwood seedling growth and survival. *Ecological Modelling* 87:69-82.
- Knorr, T. 1998. Comparison of canopy structure in bottomland and upland forests. In: W.J. Mitsch and V. Bouchard (eds.), *The Olentangy River Wetland Research Park at The Ohio State University, Annual Report 1997*, The Ohio State University, Columbus, OH, pp. 235-238.

- Liptak, M.A., L.J. Svengsouk, S.M. Johnson, and W.J. Mitsch. 1997. Wetland macrophyte development in the experimental wetlands at the Olentangy River Wetland Research Park during the third growing season 1996. In: W.J. Mitsch (ed.), *The Olentangy River Wetland Research Park at The Ohio State University, Annual Report 1996*, The Ohio State University, Columbus, OH, pp. 159-172.
- Loucks, W.L. 1987. Flood tolerant trees. *Journal of Forestry* 85:36-40.
- Malecki, R.A., J.R. Lassoie, E. Rieger, E., and T. Seamans. 1983. Effects of a long-term artificial flooding northern bottomland hardwood forest community. *Forest Science* 29: 535-544.
- Mitsch, W.J. and W.G. Rust. 1984. Tree growth responses to flooding in a bottomland forest in northeastern Illinois. *Forest Science* 30: 499-510.
- Mitsch, W.J. and Wu, X. (eds.). 1993. *The Olentangy River Wetland Research Park at The Ohio State University, Annual Report 1992*. The Ohio State University, Columbus, OH, 76 pp.
- Schamp, K., and W.J. Mitsch. 1997. Groundwater patterns before and after wetland construction at the Olentangy River Wetland Research Park. In: W.J. Mitsch (ed.), *The Olentangy River Wetland Research Park at The Ohio State University, Annual Report 1996*, The Ohio State University, Columbus, OH, pp. 85-88.